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OBSERVATIONS

ON

FOSSIL VEGETABLES,

ACCOMPANIED BY

REPRESENTATIONS OF THEIR INTERNAL STRUCTURE,
AS SEEN THROUGH THE MICROSCOPE.

BY HENRY WITHAM, ESQ.

OF LARTINGTON,

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WERNERIAN SOCIETIES OF EDINBURGH, ETC.

WILLIAM BLACKWOOD, EDINBURGH; AND
T. CADELL, STRAND, LONDON.

MDCCCXXXI.

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TO
WILLIAM NICOL, ESQ.

§c. §c.

DEAR SIR,

GRATITUDE and respect are due from every individual in society to him who promotes its real interests, by extending the bounds of knowledge. Those unaccustomed to intense study, can but imperfectly appreciate the labour and anxiety to which you have submitted in your minute and difficult examinations of the stems of numerous recent and fossil vegetables. Without your valuable assistance in so new and hazardous a task, I should have experienced much embarrassment. When labouring among the dark and unfrequented repositories of the ancient records of a former state of things, I have been cheered by the aid and encouragement of a fellow-labourer, whose discrimination and perseverance might embolden one less anxious and enthusiastic than myself. For the many acts of kindness which I have received at your hand, and more especially for the assistance rendered me in this difficult undertaking, allow me to return you my grateful thanks, and to subscribe myself,

DEAR SIR,

Your sincere friend,

HENRY WITHAM.

EDINBURGH, 1st November 1830.

by their external forms; and in many instances, these forms are obviously too much altered, to permit us to refer the objects in question, with perfect satisfaction, to any natural family. But a method has lately been discovered, by which the stems or branches may be sliced, and afterwards reduced to such a degree of thinness as to permit us to inspect the most minute remains of organic texture. The unexpected result thus obtained, has enabled me to examine numerous varieties of structure in fossil plants; and I feel confident, that I should be rendering a service to science, by presenting to the public representations of some of these varieties, accompanied by others of those recent plants to which they seem decidedly to approximate.

According to the opinion of those who have most successfully cultivated geological botany, the essential character of the first vegetation of the globe consisted in the great development and numerical preponderance of the vascular cryptogamic plants; and the great size of the Ferns, Lycopodiaceæ, and Equisetaceæ, imbedded in our deposits, authorize us to presume, that, during that period, circumstances calculated to favour the development of these plants had prevailed in a very high degree. May we not now go a little farther, and, from the recent discoveries, suppose that heat and moisture had an equal effect upon plants of different genera from those of the vascular cryptogamic? When we discover stems of fossil plants thirty, sixty, and even seventy feet long—when each torrent by its violence uncovers so many relics of ancient times—nay, whenever, by the busy ingenuity of man, the lower as well as the higher sedimentary deposits are interfered with or disturbed, some previously unobserved fossil is discovered, it is but fair to conclude that the same causes have equally affected them.

By the investigations of many of my friends, and by my own observations, I am induced (as already noticed) to think that plants of the phanerogamic class will be found to occur in greater abundance in the earlier sedimentary deposits than was before believed. The day is now arrived, when doubts and difficulties as to the class and family to which they are to be referred, must give way under the microscopic examination of the internal structure of these fossil plants; and I am happy in having it in my power to contribute in some degree to the elucidation of this interesting subject.

Deeply impressed with this idea, I feel most anxious to convince those who are desirous of forwarding this difficult and much neglected department of botanical geology, of the necessity of minute examinations, and repeated comparisons of the different sections of plants belonging to both classes. In some, they will find the vegetable structure of these stems retaining all its original beauty; while in others, owing to the different states of decomposition, they will perceive numerous and violent distortions. In many of the stems, they will find but a mere remnant of structure, the other parts being filled up generally by percolation with foreign matter, often arranged so beautifully and symmetrically, as at first sight to induce a belief that the original vegetable structure remains unimpaired. In such cases, the observer will require to repeat his observations, and extend his comparisons, before he can arrive at any safe or satisfactory conclusion.

When he has become acquainted with a few general arrangements, by which nature has characterized the groups into which she has thrown her productions, the observer finds that the cloud which before darkened his understanding is gradually dispelled. But this result can be obtained only by the most minute and often repeated microscopic observations and comparisons, not only of fossil plants with each other, but of fossil and recent species together.

My principal object in presenting this work to the public, is to impress upon geologists the advantage of attending more particularly to the intimate organization of fossil plants; and should I succeed in exciting their attention to this hitherto neglected study, I should feel a degree of satisfaction which will amply repay my labour. The pleasure which I have derived from my investigations, will be heightened by the reflection, that I have communicated their results to my fellow labourers. At the same time, I may, without presumption, hope, that the representations which I here offer of the organic structure of fossil and recent vegetables, will tend to throw some light on the nature of plants hitherto seen in a very obscure manner.

If the attention lately paid to the study of fossil conchology has been so highly instrumental in clearing up the many doubts respecting the different

sedimentary formations ;—if the works of Baron CUVIER and others, founded on the early observations of WERNER, have afforded us so many interesting proofs of successive creations, from those of the early inhabitants of the deep, up to the more complicated structure of the bird and the quadruped ; —may we not expect equal pleasure and instruction from an application to the study of these ancient vegetable remains, which, when once properly examined, will facilitate our knowledge of the forms, characters, and qualities peculiar to each epoch, and of the degree of temperature and humidity which must have existed during each successive period ?

In the following pages, I propose, *1st*, To offer some remarks on the Vegetation of the first period of the Ancient World, that is, from the first deposit of the transition series to the top of the coal-field ; *2dly*, To present an account of Fossil Vegetables found at Lennel Braes and Allanbank Mill, in Berwickshire ; *3dly*, To exhibit representations of the organic texture, as discovered by the microscope, of several fossil plants of the Coal-formation, Mountain Limestone group, and of the Lias, together with corresponding representations of recent plants, of similar or analogous structure, and comparative views of other fossil and recent vegetables, accompanied with descriptive references ; and, *4thly*, To conclude with some general remarks on the varieties represented and described, and on the subject of fossil plants in general.

I here beg leave to express my grateful thanks to my friend Professor GRAHAM, for his kind and prompt assistance in furnishing me with stems of recent monocotyledonous plants from the Botanical Garden, which has enabled me to compare the texture of the recent and fossil plants of that tribe. To my indefatigable friend Mr NICOL, I also feel peculiarly obliged, for providing me with beautifully prepared sections of plants ; and to Mr MACGILLIVRAY, for his unremitting attention and assiduity in the difficult task of executing the beautiful drawings from which the engravings have been made.

SECTION I.

REMARKS ON THE VEGETATION OF THE FIRST PERIOD OF THE ANCIENT WORLD, OR FROM THE FIRST DEPOSIT OF THE TRANSITION SERIES TO THE UPPER LIMIT OF THE COAL FORMATION.

BEING firmly persuaded that the great objects of geology will be much advanced by a serious attention to the history of the vegetation of the different epochs, from the most remote period of organic creation down to the present day, and being anxious to assist in promoting a spirit of inquiry in this country, as ardent as that of our continental neighbours, I have devoted a portion of my time to the examination of different coal-fields and mountain limestone groups, with the view of corroborating the inferences of the ingenious French naturalist, M. ADOLPHE BRONGNIART, who has lately laid before the world many judicious remarks upon this interesting but obscure branch of science. To CUVIER, STERNBERG, BOUÉ, BROWN, D'URVILLE, and others, we owe the elucidation of much that had previously been unknown in this dark field of early existence; but to M. ADOLPHE BRONGNIART it was reserved to present to the public a classification so natural, and generally so clear, as greatly to facilitate the labours of those who interest themselves in such pursuits.

Impressed with the importance of the subject, I first of all availed myself of the kindness of Mr DOLPHIN, head-agent to Messrs HALL and COMPANY, who solicited me to explore a vein called Jefferies' Rake, in the Derwent Mines, near Blanchland, in the county of Durham. Having travelled up the adit about three-fourths of a mile, we began to descend, by the assistance of ladders. At the depth of about fifty-five fathoms below the surface, in a bed of sandstone nearly 40 fathoms thick, we were gratified

by a sight of some magnificent specimens of plants belonging to M. BRONGNIART's first period of vegetable creation. The two varieties which presented themselves, appeared to belong to his third class, the vascular cryptogamic. The first was referrible to the *Stigmariæ* (*Lycopodiaceæ*); the second to the *Sigillariæ* (*Filices*). The latter were fine specimens, of great circumference. Two of them, which were situated in the space cleared out to get at the lead-ore, stand erect, and have their roots firmly imbedded in a thin stratum of bituminous shale, much carbonized. I should think the height of one of these prodigious fern stumps may be about five feet, while its diameter probably exceeds two. The other, which has been kindly presented to me, may be seen in my museum, at No. 14, Great King Street.

It has, I understand, been the opinion of some gentlemen who have visited these ancient relics, that they were washed into, and deposited in, their present situation by some aqueous revolution. To this conclusion I must object, for two reasons; *1st*, Because the roots are firmly imbedded in the shale, as if they had remained undisturbed in their original earthy envelope; and, *2dly*, Because there may be discovered in each cheek of the vein, other trunks of these members of the ancient flora, in the solid rock, the position and appearance of which are more consistent with the supposition of their having grown on the spot where they are at present found. The confused heaping, breaking, and general indications of violence, which characterise diluvial action, are not seen here.

In proceeding towards the east, I received much valuable information from my intelligent friends, Mr BUDDLE, an eminent coal-viewer upon the rivers Tyne and Wear, and Mr HUTTON of Newcastle, whose ardour in this department of science is so well known.

In the great Newcastle coal-field, the fossil plants are generally in a horizontal position, or parallel to the strata, in the greatest possible confusion, much broken, and with their parts far separated. Indeed, the confusion is the most serious difficulty which the observer has to contend with. It is, however, difficult to trace the operation of a current of water, that has swept off the weaker vegetables, and deposited them where we now find them so beautifully preserved. Notwithstanding this, there are to be found, in consider-

able abundance, in various positions, large and strong trunks of plants, which appear to remain in their natural position, and which have been able to withstand the force of such torrents, if it can be proved that any such existed. These vertical plants I have generally found to be *Sigillariæ*. The *Stigmariæ* and *Calamites*, on the contrary, do not appear to have been sufficiently strong to resist any revolutionary influence.

Below the high main seam (which, according to Mr FORSTER's section of the strata, is 150 yards below the surface), in a bed of sandstone, there are numbers of fossil plants standing erect, with their roots in a small seam of coal lying below. These stems, as will be perceived by the following diagram, are truncated and lost in the seam, leaving room to believe that they may have formed part of that combustible mass or bed.



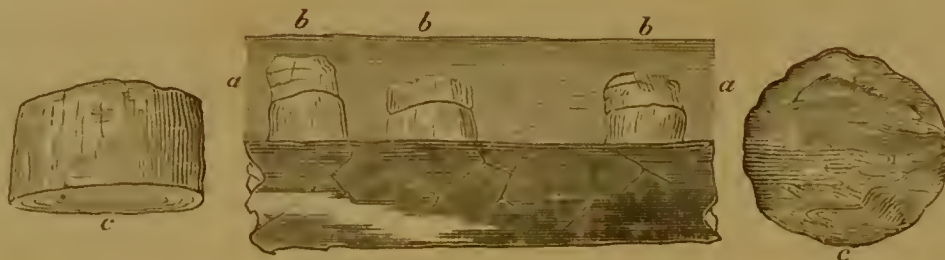
a, High main seam.

b, Sandstone, in which are seen the trunks, *d, d*.

c, Small seam of coal, in which the roots of the trunks are imbedded.

Again, in some of the seams, when the coal is worked away by the miners, the roof often falls in. This is, in a considerable degree, owing to the number of vegetable impressions breaking the coherence of the stratum, and bringing these fossils along with them. It is observed, that, in almost every instance, they are surrounded by a coating of very fine coal, about one-half or three-fourths of an inch thick, having a polished surface, with very little attachment to the surrounding matter. This, I doubt not, is the cause of the fall, the fossil dropping out sometimes as much as three feet in length, and leaving a hole in the roof almost perfectly circular. Often it falls in

these large pieces; but sometimes the nature of the shale, of which its substance is composed, causes it to fall in portions of different thickness. It is to these falling pieces that the miner's expressive term, *kettle-bottoms*, applies.



a, a, Shale, containing trunks.

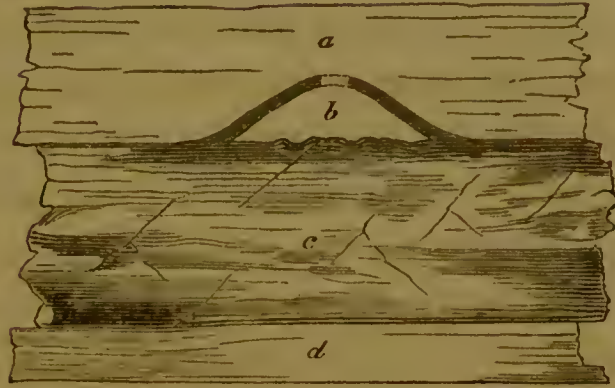
b, b, b, Trunks, *in situ*.

c, c, Two views of a fallen portion, or kettle-bottom.

These fossil plants are from two to eight feet in circumference. The occurrence of numerous impressions of leaves and fragments of plants, observed in various parts of the shale, of which the substance of these fossils is formed, is to me, I must confess, very difficult of explanation. Some years ago, a friend of mine found a kettle-bottom at Old Kenton Colliery, eighteen inches in diameter, coated with fine coal, the substance of which was entirely of mineral charcoal, with a mixture of earthy matter and pyrites. A portion of this specimen is in the Collection of the Geological Society. It is much to be regretted, that hitherto none of these interesting fossils have been followed into the strata. We do not know how far they extend, or to what height they are standing*.

In the coal districts of Scotland, among the troubles which affect the roofs of coal, there is one of a very singular form, known by the name of *pot-bottom* or *cauldron-bottom*, and from the size of from one to five feet in diameter. One of these is represented in the annexed diagram.

* I have been informed, since the above was written, that Mr Wood of Killingworth has succeeded in tracing some of these stems several feet into the solid rock.



a, Roof of Coal ; Argil, with sand.
b, Pot, or Caldron-bottom.
c, Bituminous Coal.
d, Pavement of Coal ; Fire-clay.

In working the bed of coal, the miner generally knows that he is approaching one of these, by the coal becoming twisted, and more difficult to work ; and this continues till the trouble in the roof is passed. The general form is that represented in the figure, when, of course, the mouth of the pot is inverted. Its sides are generally lined with coal, from one-eighth of an inch to an inch in thickness, and the pot or cavity is filled up with stone of the argillaceous kind, or fire-clay, having generally less mixture of sand than the roof-stone around. The under surface of the stone which fills the pot, is irregular and waving, not smooth, like the roof adjoining. Although the coal which lines the pot is connected with the main bed of coal, it is of a texture altogether different, having a bright appearance like jet, and breaks into very minute cubical pieces. Sometimes it has no bitumen in it, and is of the nature of glance-coal. The sides of the pot are generally as smooth as glass, with small furrows or grooves in a vertical direction, so that there is very little tenacity between the sides of the pot and the stone which fills it up. This circumstance renders these troubles very dangerous, particularly when they are of a large size, as they fall without giving any warning. The peculiar singularity attending this trouble, is the twisted texture and alteration which are found in the bed of coal immediately under and adjoining it, without any mixture of the stone in it which fills up the pot. There is sometimes no lining of coal ; and it generally happens that a piece of the

stone which fills up the pot, adheres to the upper part of the cavity, so that the trouble may go farther up into the stratum than is imagined. This trouble requires to be minutely investigated; and the pavement upon which the coal rests should be examined under the trouble, to ascertain if it is in any way altered in its structure, as is the case with the coal. For my information respecting this interesting phenomenon, I am indebted to my much respected friend Mr BALD, who, I am happy to say, intends at an early period to direct his attention more particularly to these singular objects.

Were further proof of the vegetable nature of coal wanting, the fact of the occurrence of *Segenariæ* (*Lepidodendra* of STERNBERG) in the solid coal, the thin layers of incoherent carbonaceous matter, having much of the silky aspect of charcoal, alternating with layers of good bituminous coal, and bearing the form of *calamites* in a very perfect manner, should go far to establish the vegetable origin of these combustible beds.

I shall now add some observations on the neighbourhood of Edinburgh. Here, again, I have been fortunate in obtaining many specimens of vascular cryptogamic plants, whose original substance has been transformed into one of the same nature as the sedimentary deposits in which they were entombed, with the exception of their bark or outer coating, which is always carbonized. The prevailing plants of this district, like those of the Newcastle coal-field, appear to be *Sigillariæ*, *Lepidodendra*, *Stigmaria*, and various *Calamites*.

I may here mention, that, in the neighbourhood of Burntisland, in Fife-shire, one of these vegetable fossils, referrible to the genus *Stigmaria* of BRONGNIART, the *Variolaria* of STERNBERG, occurs in a limestone. This is a circumstance by no means of common occurrence. The limestone does not contain any coralline remains, so abundant in the limestones of the neighbourhood, and, in appearance, as well as in chemical composition, varies little from the limestone of the Portland oolite. A deposit of limestone also occurs at Hatton near East Calder, and at Burdichouse near Edinburgh, containing impressions of terrestrial vegetables. This lime-

stone, although so striking in its mineralogical appearance, is, however, by recent examination, proved to be a member of the mountain limestone.

The account of a large fossil tree which was exposed in the lower part of Craighleith Quarry, near Edinburgh, in 1826, will more properly be given in the Third Section, as I have presented the appearances which its organic texture exhibits under the microscope. The height of this gigantic plant was 36 feet, its diameter at the base 3 feet. It lay nearly in a horizontal position, parallel to the stratification of the sandstone in which it was imbedded. It will be seen, from the structure of this tree, that it is apparently referrible to the Coniferæ. This plant, therefore, as well as others of which I shall take particular notice, forms an exception to the supposed general distribution of the primitive vegetation.

Thus, in these great coal-fields, we find the opinion of M. A. BRONGNIART most completely verified, namely, that the vascular cryptogamic plants had a vast preponderance in their numerical proportion; and, in fact, of 260 species discovered in this terrain or period, 220 belong to that class. "Should, however," adds M. BRONGNIART, "more precise observation, or new discoveries, make known in the old formation some plants of more than one of the classes which we have admitted, or even some species of one of the classes which have appeared to us to be wanting at this epoch, still the essential relations of these classes to each other, would be but slightly modified. Thus, it might be proved that certain, yet little known genera of the coal-formation are true dicotyledonous plants, yet it would not be the less certain, that the vascular cryptogamic plants were by much the most numerous vegetables during the first period of vegetation." The same remarks he makes respecting the lias, and other formations. Thus, whatever discoveries may be made among the vegetables of this period, from the first deposit of the transition rocks to the top of the coal-field, yet the essential characters can be but slightly modified, and this period will always remain distinct. Notwithstanding these remarks, I think we have reason to believe, from the great numbers of Coniferæ found in the mountain limestone group of Berwickshire, that a much greater proportion of these plants

will be detected in this first period of vegetation than was formerly suspected.

The more, therefore, that geologists will interest themselves in promoting the examination of these ancient relics, the more likely are they to accelerate the approach of a period when we shall be able, with greater certainty, to ascertain each deposit by the peculiarity of its vegetable fossils.

The essential character of this first period of vegetation, is thus proved to be the predominance of vascular cryptogamic plants; and we have here a most striking example of the great development which the species in question attained at this early period of vegetable creation, when the two great agents, heat and moisture, had evidently exerted an extraordinary influence.

Geologists have entertained, and still entertain, very different notions respecting the origin of Coal. It appears very probable, from the singular development of the vegetation of the first period, that these different combustible beds may have been deposited as a kind of peat, of greater or less extent, formed from the remains of vegetables, and on which other vegetables still grew. This opinion is, I think, greatly confirmed by the description just given of the Newcastle coal-field. It appears also the more probable, as it is well known that many plants of the families composing this early vegetation grow abundantly in places of this kind at the present day. The *Equiseta*, the *Lycopodia*, the *Osmunda regalis*, the *Pteris aquilina*, various *Aspidia*, and other ferns, are indigenous to our peat soils. Again, we can scarcely doubt, that, at this remote epoch, our atmosphere had a very different composition from what it now has, and that it exerted a more powerful influence upon the development of these constituents of our combustible beds.

The comparison of the successive development of vegetables and animals, is not one of the least remarkable parts of the study of these fossil organized bodies. This is beautifully expressed by M. ADOLPHE BRONGNIART. He displays, by philosophic reasoning, the effects produced by a supposed cause. He states, with great perspicuity, why land animals did not exist at one period—why cold-blooded animals became more numerous at another period; and, lastly, gives cogent reasons for the appearance of

animals of a more complicated structure, the Mammifera and Birds, in the fourth period. M. BRONGNIART's reasonings upon this subject are so well epitomized by Professor JAMESON in the Philosophical Journal for March 1829, that I find it unnecessary here to enter into more minute details.

The study of this occult science truly opens to view a field of the most interesting nature. It exhibits a world little looked into, or thought of, owing to the obscurity in which it is enveloped. It displays the early, the successive, the magnificent works of the GREAT CREATOR, which before were all supposed to have been drowned and scattered about by the mighty gushing of a universal deluge. It recalls in some measure those primeval forests, never seen by human eyes, which decorated the surface of the ancient world; and in leading us to the contemplation of the stupendous operations of which it exhibits the traces, carries us into the true philosophy of the science of geology.

SECTION II.

REMARKS ON THE VEGETABLE FOSSILS FOUND AT LENNEL BRAES, NEAR COLDSTREAM, AND AT ALLANBANK MILL, IN BERWICKSHIRE.

THE neighbourhood of Coldstream, on the banks of the Tweed, presents a multitude of fossil vegetables, which occur imbedded in shale, in a state of great confusion. As plants belonging to the class to which these vegetables are to be referred, have been rarely found in any deposits of the first period of vegetation, I shall be somewhat particular in my remarks respecting them.

It has long been matter of dispute, under what class of rocks the deposits in the neighbourhood of Coldstream are to be described. Some are of opinion that they are members of the old red sandstone series, and others that they are to be classed with a much more recent deposit, the new red sandstone. The following facts, which have been observed by my intelligent friend Mr FRANCIS FORSTER and myself, will, I trust, set this question at rest.

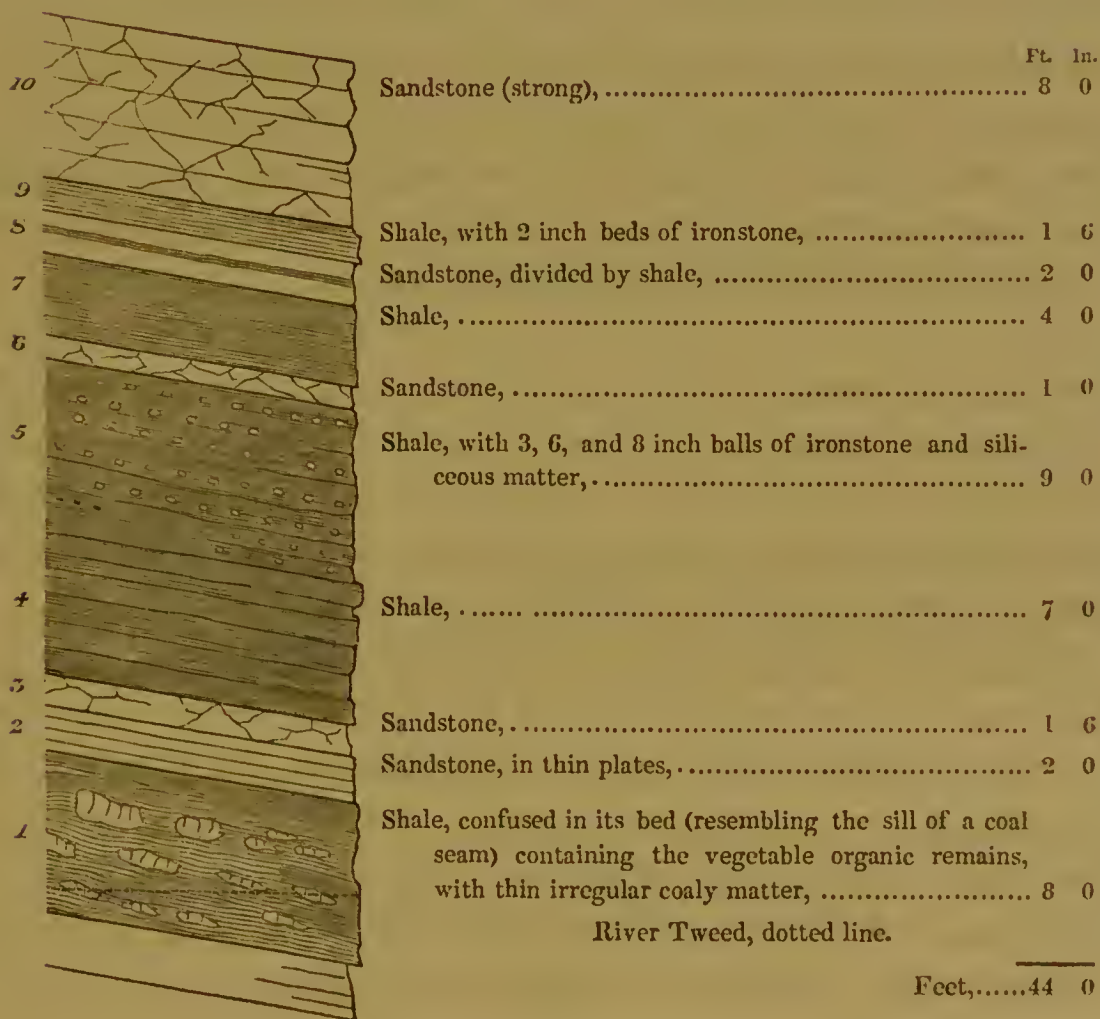
Immediately below the bridge at Coldstream, at its south end, you perceive a bed of shale, belonging to the mountain limestone series. It may be seen rising to the north-west at an angle of about 14° .

Above the bridge, on the north side, beds of sandstone, bituminous shale, and ironstone, form the cliff, rising 8° to the west.

Between the bridge at Coldstream and Lennel Braes, a distance of rather more than two miles, a great variety of shale and grit beds, evidently belonging to the mountain limestone series, may be seen rising to the south and south south-west, but irregular in their inclinations.

Lennel Braes, being the place most exposed to the waters of the Tweed, these ancient fossils are to be obtained there in the greatest abundance. The following section will afford a sufficiently accurate idea of the strata and their arrangement.

Line of Section N. 15° E., dip in that direction 8°.



Both banks of the river are occupied by beds similar to the above, from Lennel Braes down to a very fine sandstone cliff about three-fourths of a mile above Sir DAVID MILNE's house. This sandstone has many charac-

teristic marks of the new red sandstone formation*. It is about 45 feet in height, and nearly 120 yards in length. It dips at an angle of 9° , in the direction of north 35 east. It is underlaid at its western point by a bed of shale, containing remains of vegetables, and dipping north 37 east, at an angle of 16° .

On the south side of the river, at Twizell grounds, a similar sandstone is quarried. The position of this sandstone is altered near the bank, being bent down towards the river. It dips here 8° to the north-east, but in the western part of the quarry it appears to take a more regular course, and dips to the south at the rate of 8° . Further down the river, a bed of shale is seen abutting against this sandstone, evidently thrown up by a fault. This quarry possesses all the characters of the new red sandstone. There is also a bed of sandstone quarried in the burn side close to Milnegraden. It is of a grey colour, and close grained, affording a very fine building stone. It dips at an angle of 5° to the south south-east.

Again, a few hundred yards to the north of Coldstream, is a thick bed of very fine sandstone, belonging to the mountain limestone group, dipping to the east south-east. In its lower part, vegetable remains, mineralized with sulphate of iron, are lying in horizontal position. It rests upon a bed of soft bituminous shale, of unknown thickness, and the beds of sandstone are streaked and irregularly marked with the same substance.

Many persons having great doubts how far the coal-field, or mountain limestone group containing beds of coal, which is worked to the south of the river Tweed, extends in a northerly direction, Mr FORSTER and I proceeded from Coldstream to Greenlaw, between which places an extended and undulating plain of diluvium evidently covers the basets of many strata. On the top of the hill, south-east of Greenlaw, is a quarry of red sandstone. It dips to the south at an angle of 19° . This great

* Since writing the above, by a close examination of the red sandstone of the county, I have strong reasons to believe, that these red rocks, so much resembling in mineralogical character the new red sandstone, are subordinate members of the mountain limestone group. An account of the red rocks of Berwickshire will be published in the next number of the Transactions of the Natural History Society of Newcastle-upon-Tyne.

inclination may probably be attributed to the immediate vicinity of a whim dyke running a few yards to the north. In the direction of south 65 east (about four or five hundred yards west), this dyke has been worked to the width of twenty-seven yards. Whether this is its regular thickness, or an overflow at this point, could not be ascertained, as the quarry does not extend more than four or five feet below the surface. The sandstone in the eastern quarry shows igneous phenomena in a striking degree. Another quarry, of very red sandstone, is worked on the side of the hill south of Greenlaw. Close to the bridge over the Blackadder, at the west end of Greenlaw, a bed of red sandstone 12 feet thick, is seen rising 14° in the direction of north 65 east.

Again, at Allanbank Mill, near the junction of the Whitadder and Blackadder, are found numbers of stems of apparently phanerogamic woods; also *Sigillariæ*, *Lepidodendra*, and leaves of Ferns. This locality is about seven miles from Lennel Braes. There appears no reason to doubt, that, were the shales of this district properly examined, abundance of these ancient fossil plants might be found. This, I trust, will encourage gentlemen living in the neighbourhood of other mountain limestone groups, to pay attention to their shale deposits.

The walls in the neighbourhood of Polwarth are built of red sandstone conglomerate from Leases quarry, about three quarters of a mile to the west of this village. Immediately below the bridge crossing Langton burn, on the road between Polwarth and Dunse, a bed of yellow sandstone, four feet in thickness, is underlaid by a bed of shale four feet thick, containing layers of ironstone from six to eight inches, all rising about 22° to the north. It appears more than probable that these are members of the mountain limestone series, cropping from under the red sandstone, which forms the hills behind them to the south.

At St Helen's, two miles east from Dunse, beds of shivery sandstone and shale, nearly horizontal, containing nodules of ironstone, occur. The shale also occurs extensively on the banks of the Blackadder, twelve miles from Berwick, on the Paxton road, and is repeatedly seen bassetting out farther east on the bank of the said river.

At the bridge of the Whitadder, one mile west of Chirnside, a thick series of mountain limestone-measures dips rapidly to the east, forming a bold cliff, capped on the north side of the road by a thin detached bed, much resembling new red sandstone.

Many other remarks might here be made, but I reserve them for a future paper upon the red sandstones of Berwickshire.

The great abundance of these fossil plants in the above-named stratum, lying in a state of much confusion, must be matter of surprise to those who have paid any attention to the ancient vegetation of the coal-fields in the north of England and Scotland. In all these fields, it is well known, the vascular cryptogamic plants appear greatly to prevail; and we were but occasionally amused by some undescribed recumbent fossil, whose class, genus, or species generally occasioned much comment, and not a little hesitation.

In this position, amongst the members of the mountain limestone series, however, we have every reason to believe in a deposit of these fossil plants, of unknown extent, all apparently of the same class, and differing altogether from the vascular cryptogamic plants.

To what class are we to refer these ancient remains of a former world? They cannot be vascular cryptogamic plants, as they contain decided woody texture from the centre of the stem. They cannot be monocotyledonous, the pith not forming the greater part of the stem, and the woody parts not being composed of fasciculi, which are disseminated throughout the pithy texture of plants of that kind. They having in my opinion most decided medullary rays, it would appear to me they must be placed amongst the gymnospermous phanerogamic plants, no true dicotyledones having yet been discovered, either in the coal-field or the mountain limestone group, although the Coniferæ, to which these plants belong, are by most botanists referred to the class of Dicotyledones. As such, therefore, after repeated and most minute microscopic examinations and comparisons, not only with fossil but with recent plants, I do not hesitate to consider these numerous fossil vegetable remains.

The contorted and flattened shape of many of these ancient stems is

worthy of remark. Their external coatings are invariably carbonized. Probably their present forms may have been caused by extreme pressure, when these vegetables were in a state of decomposition, and subsequently it was that foreign substances, by percolation, took possession of the decayed portions of the plants. It is difficult also to ascertain their height, as they have been fractured. The highest stem I have been able to obtain, is not much more than four feet, and the lowest part of it about six feet in circumference. Owing to the immense superincumbent mass of stratification, this part of the research is rendered both tedious and expensive.

By the above observations, it appears therefore quite clear, that the mountain limestone group which to the south of the river Tweed contains beds of coal, by no means terminates at or near the ancient boundary of the two kingdoms, but approaches within a short distance of the transition range of the south of Scotland. It is equally evident, that this unknown extent of early vegetation seems to have been called into existence during the formation of the mountain limestone group, or in the first period of BRONGNIART's division. Now, according to that gentleman's opinion, out of six classes (with the exception of the marine, and a few uncertain plants), only two existed at that period, namely, the Vascular Cryptogamic plants, comprehending the Filices, Equisetaceæ, and Lycopodiaceæ, and the Monocotyledons, containing a small number of plants, which appear to resemble the Palms, and arborescent Liliaceæ. In fact, M. A. BRONGNIART states, that out of 260 species discovered in this terrain, 220 belong to the vascular cryptogamic.

The existence, therefore, of so extensive a deposit of dicotyledonous or gymnospermous phanerogamic plants, at this early period of the earth's vegetation, appears to demand the attention of the naturalist, and goes far to prove the necessity of more minute examination among the dark and pathless repositories of an ancient world.

SECTION III.

OBSERVATIONS ON FOSSIL VEGETABLES, ILLUSTRATED BY FIGURES,
AND PRECEDED BY GENERAL REMARKS.

ALTHOUGH the organization of vegetables is sufficiently known, in so far as regards the distinctions by which the larger groups are defined, the more peculiar features which the families and genera present, have not yet received that degree of attention which they require. In the present state of science, it is impossible, when a section of a tree is presented, to decide upon its species, and in most cases even upon its genus. In fact, I am not aware that any investigations have been made in respect to the internal organization of fossil plants; nor, at the commencement of mine, did I meet with any person who possessed the least practical knowledge of the subject, excepting my friend Mr NICOL, to whom the general distinctive features of some of the tribes have been for some time familiar, and to whom, as I have already said, I am under the greatest obligations for his prompt and able assistance. This being the case, it will readily be understood how difficult a task it has been to me, to come to any satisfactory results in my investigation of fossil vegetables. In the elucidation of most of those which I have figured, it must be expressly declared, that I do not speak decidedly as to the genus to which they belong, but merely make an approximative reference; although in others the resemblance to recent species is so perfect that no doubt can exist as to their ordinal or generic identity.

The vegetable kingdom has been variously arranged. It is not, however, my intention to speak of the differences of opinion among botanists in this matter. M. ADOLPHE BRONGNIART proposes a distribution of plants into six great Classes, as follows:

I. AGAMIC PLANTS.

These plants have an organization consisting entirely of cellular tissue, or intersecting tubular filaments, without vessels; are entirely destitute of leaves, and have only, as organs of reproduction, very minute seminula, which appear to be developed without fecundation, and which are contained immediately in membranous conceptacles, similar to the filaments or cellules of the general tissue of the plants.

To this class belong the *Algæ*, *Fungi*, and *Lichens*.

II. CELLULAR CRYPTOGAMIC PLANTS.

The plants of this class have an entirely cellular organization, but they possess leaves having a structure and functions similar to those of the more perfect vegetables. There are sexual organs, and the seminula are contained in conceptacles of a very complex organization.

This class contains the *Hepaticæ* and *Musci*.

III. VASCULAR CRYPTOGAMIC PLANTS.

The cellular tissue, which is diversiform, almost always contains distinct vessels, most commonly tracheæ or false tracheæ; the leaves are highly developed, and furnished with cortical pores; the stems are often very large and arborescent, bearing some resemblance in their structure to those of the monocotyledones; and the organs of reproduction appear always to consist of two distinct sexes, which produce seminula contained in conceptacles of somewhat complicated organization.

This class contains the *Equisetaceæ*, *Filices*, *Lycopodiaceæ*, *Marsiliaceæ*, and *Characeæ*.

IV. GYMnosPERMOUS PHANEROGAMIC PLANTS.

To this class belong the very remarkable families of *Cycadeæ* and *Coniferæ*, which cannot be referred to any of the other classes, as their seeds,

which are destitute of capsules, receive directly the action of the fecundating substance, and their stems differ in many respects from those of the true Dicotyledones.

V. MONOCOTYLEDONOUS PHANEROGAMIC PLANTS.

In this class, the female organs of reproduction consist of ovules contained in an ovarium, which transmits to them the influence of the fecundating fluid; the embryo has only a single cotyledon; the stem is herbaceous, bulbiform, or arborescent, is formed of fibro-vascular fasciculi, is developed by its central part, and is destitute of concentric rings or distinct bark.

To this class belong the *Gramineæ*, *Junceæ*, *Cyperaceæ*, *Liliaceæ*, *Palms*, &c.

VI. DICOTYLEDONOUS PHANEROGAMIC PLANTS.

The female organs of reproduction are of similar structure to those of the last class. The embryo has two cotyledons. The stem is herbaceous, or woody, and in the latter case is formed of concentric layers, and receives its development from the exterior.

This class contains the greater part of the more ordinary vegetation of the present epoch.

Of the fossil species which I have examined, with reference to their internal organization, none belong to the first three classes.

Hitherto, the attention of geologists has been exclusively confined to the external forms of fossil plants; and these forms, illustrated by reference to living species, and to vegetable anatomy, have afforded characters by which numerous species and genera may be distinguished with accuracy. But the supposed destruction of the internal structure of most fossil plants, and the difficulty of applying the microscope to those which evidently retain it, have hitherto prevented our becoming acquainted with the organization of these plants. Many fossil vegetables are converted into a mass of car-

bonaceous matter : others are filled up with sand, and other substances, the external part, or cortex, alone remaining ; but it has been found that many retain their original structure, the interstices being filled up by calcareous or siliceous crystallizations. A method has lately been discovered, by which the organization of the latter may be satisfactorily examined.

This method, which I have had the pleasure of recommending to the York and Newcastle Philosophical and Natural History Societies, and of which a particular account will be given elsewhere, may here be briefly described as follows :—A slice, or thin fragment, is obtained in the usual manner. One side of it is ground and polished, and is then applied to a piece of plate or other glass, by means of a transparent gum or resin. The other side is then ground down, parallel to the glass, and, on being brought to the necessary degree of thinness, polished. By this means, the internal structure may be as distinctly seen as in the slice of a recent vegetable.

As might be supposed, the remains of the internal organization, thus displayed, are frequently distorted and disrupted in various ways, crushed into confused masses, or widely distended and separated. In examining them, therefore, caution is required, lest the regular be confounded with that which has been modified by various causes. The crystallization of the infiltrated substance has operated powerfully, among other causes, in producing these modifications. In general, the calcareous matter has crystallized in divergent prisms, and has thus given rise to a kind of cellular appearance, very readily distinguishable from the true, but which a novice might easily interpret into the regular texture of a cellular or agamic plant ; while the siliceous or calcedonic has arranged itself in parallel undulations or series of curves. The appearances produced by the two modes of crystallization are very distinct, insomuch, that a person might in many cases pronounce with accuracy as to the infiltrated substance, without using any other means of detecting it than ocular inspection.

The regularity of structure displayed by many fossil vegetables is truly astonishing. Many of them exhibit an internal texture as perfect as can be obtained from the nicest slice of a recent plant,—of which many examples will be seen in the Plates. The structure thus disclosed often corresponds

so precisely with that of recent stems, that one can hardly hesitate to refer the one and the other to the same genus, although the differences exhibited by recent species of a genus are often so slight, that there appears little hope of our being able to distinguish fossil species by their internal structure, without including other characters.

This much being premised, the remarks which I have to offer will answer better as referring directly to the Plates, than as forming the subject of a separate essay.

EXPLANATION OF PLATE I.

THIS Plate contains representations of the internal structure of Recent Plants belonging to the Gymnospermous Phanerogamic, Monocotyledonous Phanerogamic, and Dicotyledonous Phanerogamic Classes. The portions represented are of very thin slices, viewed by transmitted light, and magnified about fifty-five times.

Fig. 1. *American Fir*. Transverse section, shewing part of four of the concentric layers.

Fig. 2. Indigenous *Scotch Fir*, from Invercauld, *Pinus sylvestris*. Transverse section, shewing a concentric layer, with part of two others.

Fig. 3. *Norway Fir*. Transverse section, shewing a concentric layer, with part of two others.

Fig. 4. *Common Yew*, *Taxus baccata*. Transverse section, shewing part of four layers.

Fig. 5. *American Cedar*, from Mobile. Transverse section, shewing part of two layers.

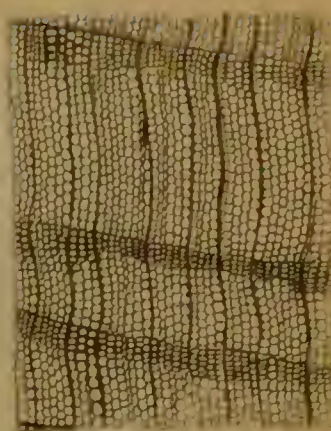
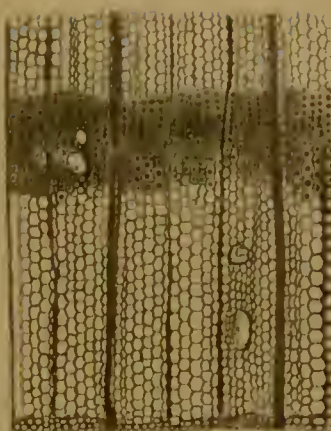
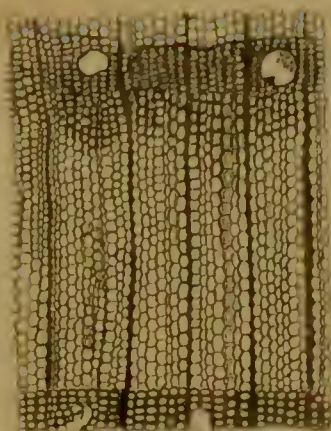
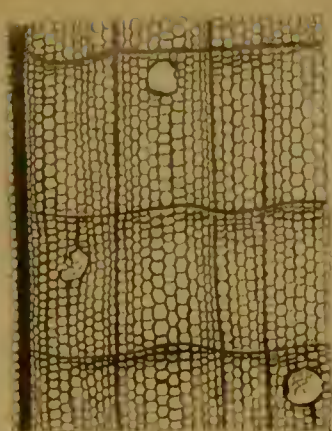
These portions of sections will be understood by making reference to Fig. 14, by which is represented part of a transverse section of a twig of *Pinus balsamea*, shewing, in the centre, the *pith*, composed of somewhat hexagonal cells, two entire *woody layers*, a portion of a third, the *inner bark*, the *outer bark*, and the *epidermis*. Figs. 1, 2, 3, 4, and 5, then, represent

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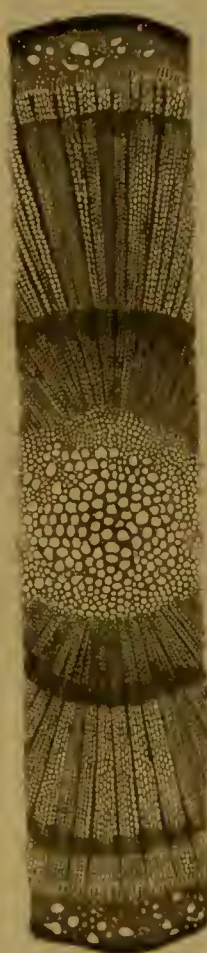
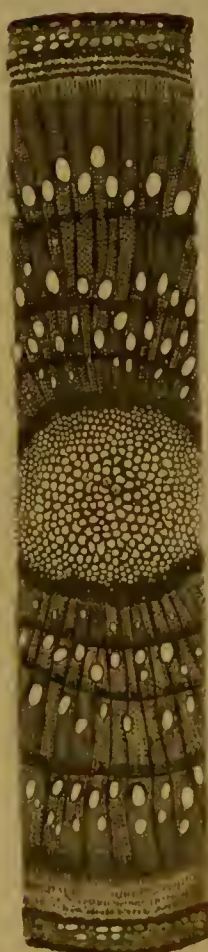
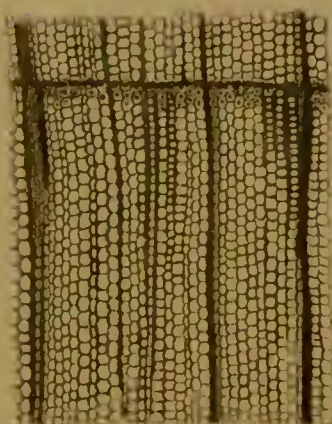
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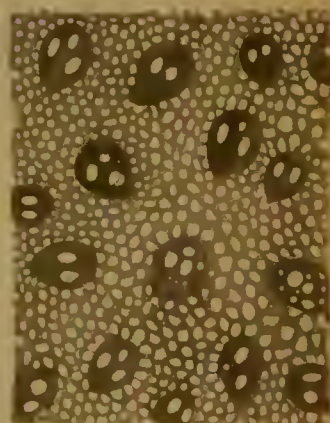
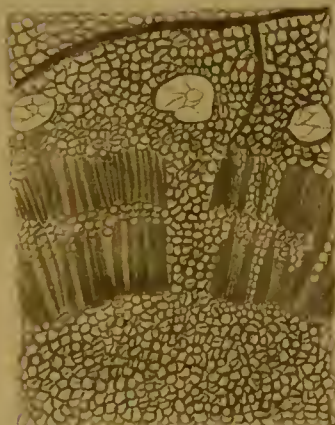
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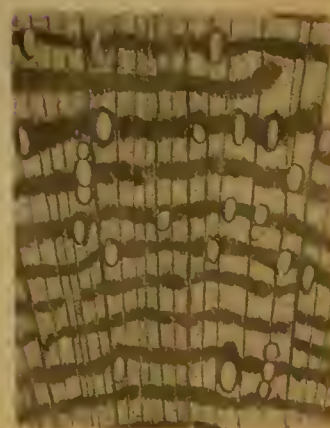
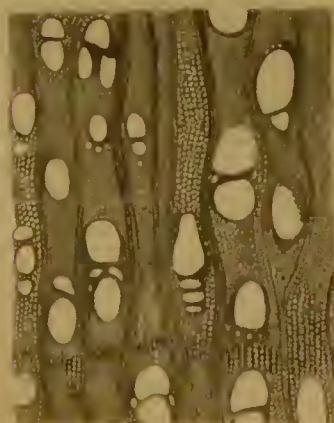


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portions of concentric woody layers of various trees belonging to the family of *Coniferae*.

This family consists of trees and shrubs, the internal structure of whose stems presents the following arrangement. There is a central column of cellular texture named the *pith*, around which is developed a cylinder of *woody texture*, which, in its transverse section, shews divergent lines, with intervening cells. The divergent lines are named *medullary rays*, or *insertions*. According to the age of the stem, branch or twig, there are fewer or more of these woody layers, one being formed annually. The woody layers are produced by the liber or inner layer of the bark, and the increase thus takes place from without, and not from the centre or pith. Irregular vacuities are frequently formed in the woody texture, partially filled with irregular cellules, and sometimes containing concrete juices. They are named *Lacunæ*, and are seen in Figs. 1, 2, and 3. I have not observed any in the Yew, or American Cedar. It will be observed in the figures generally, that the texture becomes denser towards the outer margin of each concentric layer.

Fig. 6. *Cycas revoluta*. Transverse section, shewing a small portion near the centre of a young stem. The cellular tissue is very irregular. A portion of the double circle of fibres is seen, as well as three lacunæ, and part of a fasciculus of spiral vessels. As no fossil plants of this genus have occurred to me, I shall not further insist on the organization of the Cycadeæ.

Fig. 7. *Mahogany, Swietenia Mahagoni*. Transverse section. The layers here are not well defined, a circumstance frequently observable in trees which grow in warm climates. With reference to the specimen here figured, it is necessary to remark, that the portions of it which have been cut very thin, present a cellular appearance, while those which are thicker present a more opaque aspect, with minute apertures of a circular form.

Fig. 8. *Common Oak, Quercus Robur*. Transverse section, shewing part of three layers. The layers here are well defined, and are moreover marked towards one of their margins by a denser texture.

Fig. 9. *Grey Poplar, Populus canescens*. Transverse section, shewing part of two layers.

Fig. 10. *Sandal*, or *Sanders Wood*. Transverse section. This wood approaches in its characters to the above, but is more compact in its texture, and has the layers united, without any appearance of the lines of junction so apparent in the others.

These portions of sections will be understood by referring to Fig. 15, which represents part of a transverse section of a twig of the *Common Ash*, *Fraxinus excelsior*. Here there are seen,—a central column of cellular texture, the *pith*; concentric *layers* of woody texture, shewing divergent *medullary rays*, elongated cellular tissue, and large openings of vessels; and, lastly, the *bark*. In short, the general structure and mode of growth are the same as in the *Coniferæ*; but a transverse section of the trees of this class, the *Dicotyledonous Phanerogamic*, is easily distinguished from that of trees of the former class. The large openings of the vessels, in particular, symmetrically arranged, between the more or less flexuose medullary rays, and the denser texture of the cellular part, are characteristic.

Fig. 11. *Sugar Cane*, *Saccharum officinarum*. Transverse section of a portion of the stem, shewing opaque spots of an oval form, and perforated by vessels, contained in a uniform mass of cellular tissue or parenchyma.

Fig. 12. Transverse section of part of the stem of a species of *Calamus*, exhibiting a similar arrangement.

The appearances here will be understood by referring to Fig. 13, which represents a portion of a transverse section of the stipe of *Rhapis flabelliformis*, from the centre to the surface. Here the structure is very different from that of the other two classes. These plants belong to the class of the *Monocotyledonous Phanerogamic*, which, in the transverse section of their stems, exhibit vascular bundles imbedded in cellular texture, without concentric layers or regular bark.

In conclusion,

Fig. 13. represents the *Monocotyledonous* stem, shewing the vessels imbedded in cellular tissue, which is looser at the centre, more condensed toward the surface, but not arranged in regular series, bounded by medullary rays, as in the *Coniferæ* and *Dicotyledones*. There are no medullary rays, nor any appearance of concentric layers.



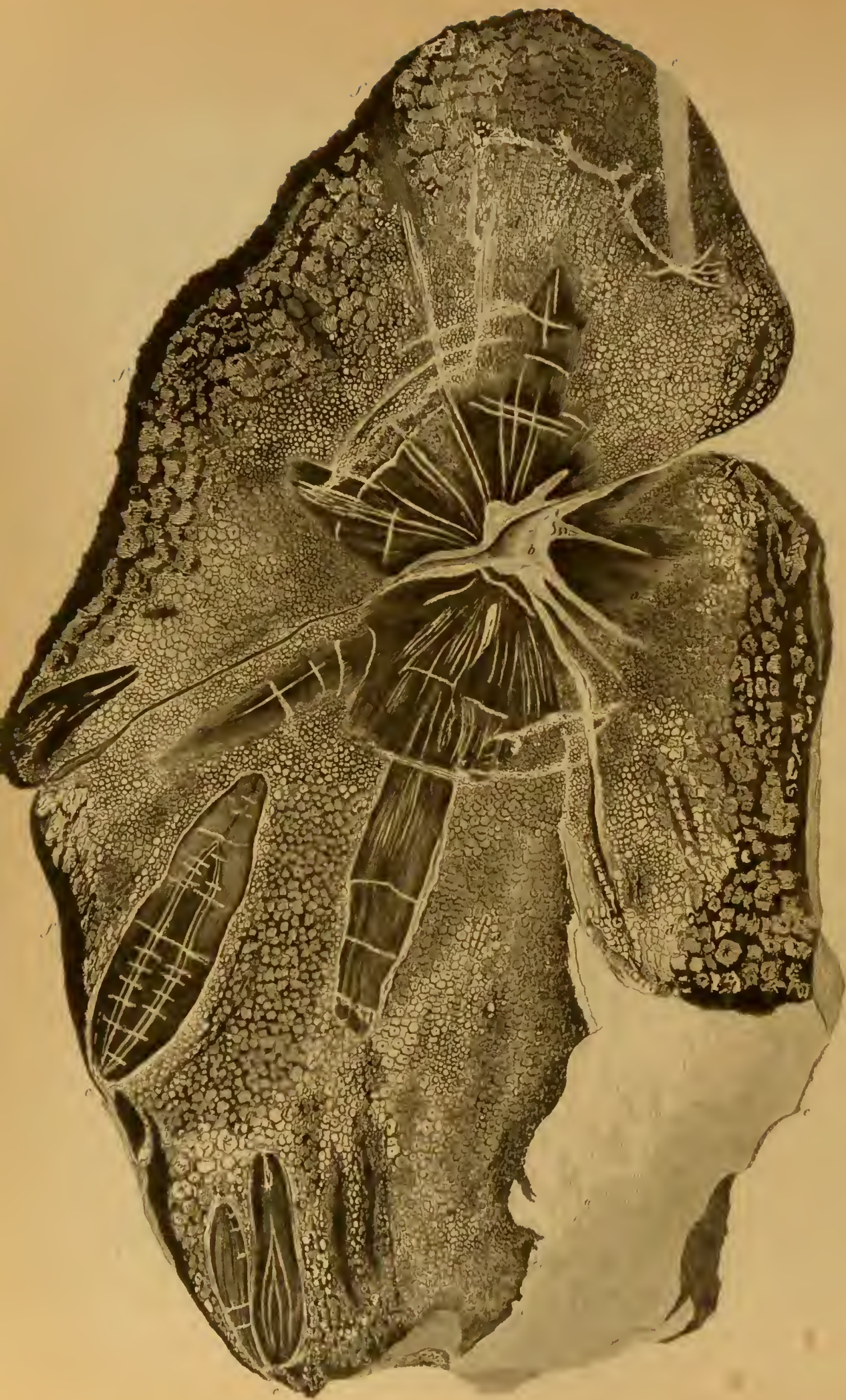


Fig. 14. represents the Gymnospermous Phanerogamic stem, shewing a central pith, woody layers separated by a condensed line, and consisting of elongated cellular texture arranged in regular series; medullary rays which run continuously from the first or inner layer to the bark, new ones, commencing at the line of separation of the layers, being added; and, finally, the bark, consisting of several layers or portions.

Fig. 15. represents the Dicotyledonous stem, shewing a central pith, woody layers separated by a condensed line, elongated cellular texture in series, large regular openings of vessels, medullary rays, which run continuously from the pith to the bark, new ones commencing at the lines of separation of the layers being added, but all more or less flexuous, being bent round the vascular apertures; and, finally, the bark.

In structure, the stems of the Dicotyledonous Phanerogamic, and Gymnospermous or Polycotyledonous Phanerogamic plants, are more allied to each other than those of the Monocotyledonous Phanerogamic plants are to either; and in this order I have represented and explained them.

PLATE II.

THE figure here represents a transverse section, viewed by reflected light, and diminished one-half, of a portion of one of the Fossil Vegetables mentioned at p. 14. as occurring near Lennel Braes, on the Tweed, in Berwickshire. Their situation in the lower bed of shale has been already mentioned.

These stems are generally distorted and flattened. They are invested with an external coat of carbonized matter, in all respects resembling the purer kinds of common coal. It is difficult to ascertain their length, as they have been fractured at short intervals. The highest stem which I have been able to obtain, is not much above four feet, and the lowest part of it about six feet in circumference. No two stems, or portions of stems, possess the woody appearances in their interior alike, some retaining them

in the centre, others having them distributed in various parts. The exterior is irregularly grooved in the longitudinal direction. No indication of branches was observed. The nature of the interior will be best understood by referring to the figure.

Within an external layer of coaly matter *f, f, f*, is exhibited an irregularly oval surface, presenting various modifications of colour and texture.

b, Is the centre, converted into calcareous spar, of which substance all the white rays and veins consist.

a, a, a, Portions retaining organic texture, and arranged in a radiating manner, from the centre *b*, towards the circumference, but losing themselves in the apparently cellular mass of which the greater portion of the stem is composed.

c, c, c, Portions of the same nature as *a, a, a*, dispersed irregularly, and presenting in the transverse section an oval or oblong figure, but running continuously through the mass, in its longitudinal direction.

d, d, d, The mass in which the organic portions are imbedded. It consists of crystallizations of calcareous spar, surrounded by carbonaceous and clayey matter, and presents somewhat of a cellular appearance, but is not organic.

e, e, Indurated argillaceous matter.

This much is shewn of the external forms and internal arrangement of these remarkable stems, as seen by the naked eye. What the microscope discloses, will be seen in the next Plate.

The following is the analysis of a portion of one of these fossils, weighing 20 grains :

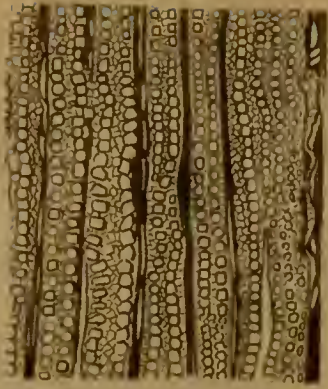
Carbonate of Lime,	16.65
Carbon,	3.30
Iron (Peroxide),	0.68
Loss,	0.37
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	20.00 grains.



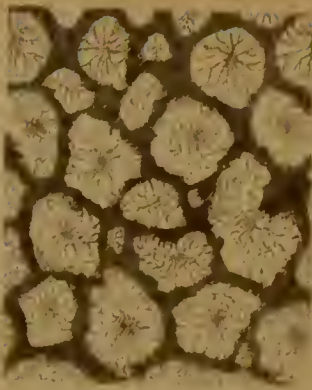
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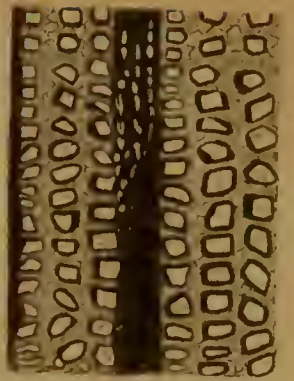
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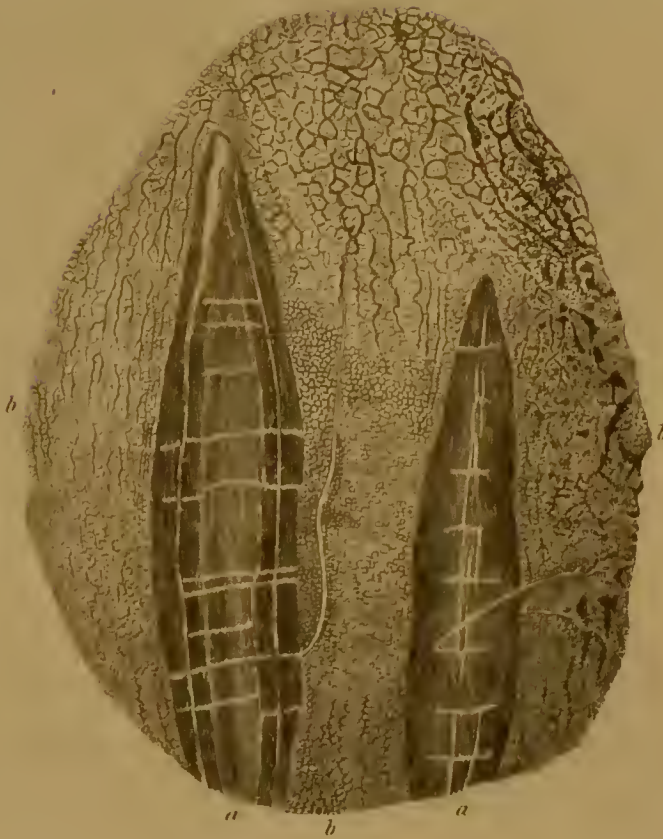
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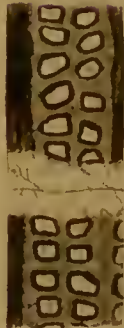
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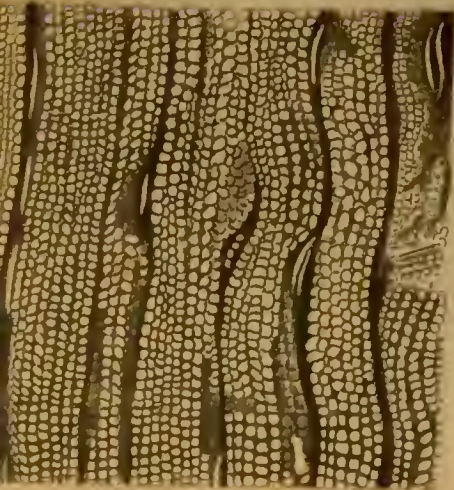
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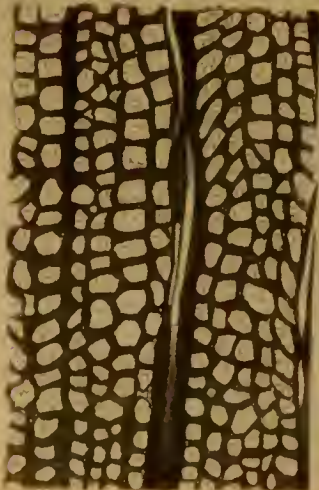
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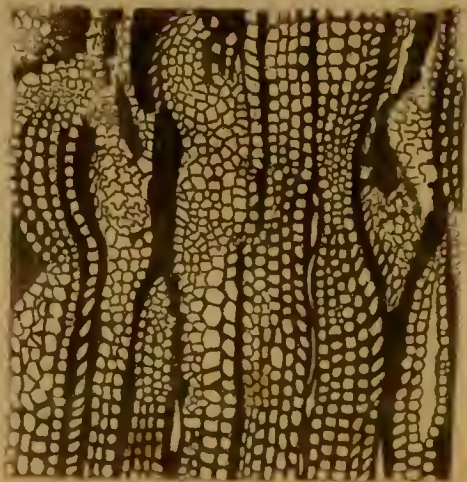


PLATE III.

THE organic texture of the fossil tree from Lennel Braes, figured in Plate II. and that of a large trunk found in Craigleith Quarry, near Edinburgh, are here exhibited, as detected by the microscope. The figures are all from thin slices, viewed by transmitted light. Two of them, Figs. 1, and 2. are of the natural size. The rest are magnified in various degrees.

Fig. 1. Transverse section of a portion of one of the fragments of the fossil tree found at Lennel Braes, of the natural size, shewing the organic parts *a, a*, imbedded in the apparently cellular mass *b, b, b*, disorganized by crystallizations of calcareous spar. The white lines, longitudinal and transverse, are veins of calcareous spar. This figure represents a thin slice, viewed by transmitted light.

Fig. 2. One of the organic parts, from another portion, represented of the natural size.

Fig. 3. Part of one of these portions of organic texture, magnified about thirty-five times.

Fig. 4. Portion of the same, more highly magnified, shewing a regular woody texture, and medullary rays.

Fig. 5. Portion of the apparently cellular part *b, b*, of Fig. 1, magnified. The divergent crystallization of the calcareous spar is here distinctly seen.

Fig. 6. Portion shewing a medullary ray, and the adjacent parts, highly magnified. The former is distinctly seen to be composed of irregular elongated cellules.

Fig. 7. Portion of the same organic texture, shewing part of a small intersecting vein of calcareous spar.

From these figures, it will be seen, that the arrangement is similar to that of the Coniferæ, as exhibited in Plate I., there being regular series of elongated cellules, forming the woody texture, together with distinct medullary rays. In these two circumstances, the texture is alike in the fossil

plant here represented, and the recent plants; but in the former, there is no appearance of the concentric lines by which the woody layers of the latter are separated. The portions represented are chiefly calcareous; but in some fragments, in which the cavities have been filled with siliceous matter, there is a distinct appearance of these concentric lines, as may be seen in Fig. 9, Plate VI. by which is represented a very regular portion of the same fossil. The want of them in the calcareous portions, may probably be owing to the more advanced state of decomposition; and in all, the resemblance to the *Coniferæ* is so striking, and the texture approaches so closely to that of these plants, that I cannot hesitate to refer the fossil in question to the *Gymnospermous Phanerogamic* class.

In the year 1826, an enormous trunk was exposed in the lowest bed of Craighleith Quarry, near Edinburgh, at a depth of upwards of 136 feet. The length of this trunk was 36 feet, and its diameter at the base 3 feet. It lay in a nearly horizontal position, corresponding with that of the stratum of hard white sandstone, in which it was imbedded. Externally, it was marked with irregular longitudinal grooves and prominences, and was encased in a layer of coaly matter, being probably the altered remains of the bark. No branches were observed. Internally, it exhibited in some places an irregular fascicular structure, of a dark grey colour, with reticulations of carbonaceous matter. The cracks and fissures were filled with calcareous spar, and the irregular cavities which it presented were lined by crystals of pearl-spar.

An analysis of a portion of this plant made by Mr NICOL, afforded the following result:

Carbonate of Lime,	60
Oxide of Iron,	18
Alumina,	10
Carbonaceous matter,	9
Loss,	3
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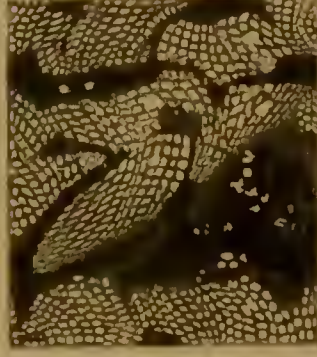
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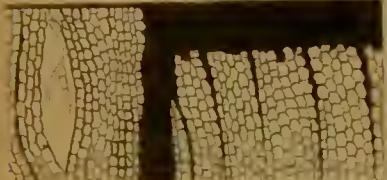
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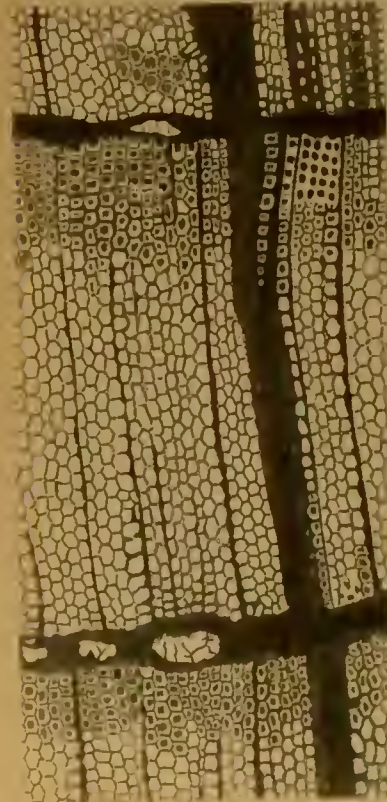
FOSSIL VEGETABLES OF THE UDAL FORMATION.

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FOSSIL VEGETABLES OF THE LIAS FORMATION.

Fig. 8. Portion of the Craigleith tree, shewing the regular woody texture, separated by medullary rays; magnified about forty-five times.

Fig. 9. Another portion of the same, magnified in the same degree, in which the woody texture and medullary rays are more or less distorted.

Fig. 10. A portion of the same tree, magnified about fifty-five times, very regular in its texture, and shewing a medullary ray irregularly lacerated.

Figs. 11. and 12. Portions of the same, shewing various degrees of separation of the woody texture or indurated vessels, their walls being thin in Fig. 11. and very thick in Fig. 12.

The absence of lines of separation of the woody layers, is the only circumstance in which these figures differ from those of the recent *Coniferae*, Figs. 1, 2, 3, 4. and 5. of Plate I. In every thing else, the accordance is perfect, and leaves no reasonable doubt as to the class to which this fossil tree is to be referred.

PLATE IV.

THIS Plate contains representations of portions of thin slices of fossil vegetables belonging to the Coal-formation and Lias, viewed by transmitted light. The eight figures in the upper part of the Plate are enlarged about fifty-five times. Of the rest, one is of the natural size, the others enlarged in various degrees, which are indicated.

FOSSIL VEGETABLES OF THE COAL-FORMATION.

A great fossil tree was found in 1829 at Wideopen, near Gosforth, in a quarry upon the estate of Mr BRANDLING, on the eastern side of the great north road, and about five miles from Newcastle. It occurred in the grindstone or firestone bed, commonly known by the name of "Grindstone Post." This bed has hitherto been supposed to be the highest member of the coal-formation of that district, and has its name from being extensively

used for grindstones, as well as for glass-houses and iron-furnaces, the stone being of a loosely aggregated texture, porous, and not liable to crack under the action of heat. The length of this fossil was 72 feet. It had no branches, but was rather abundantly marked with knots, indicating the places at which branches had shot out. Its distance from the surface was 40 feet, of which 10 were clay, the rest sandstone.

Fig. 1. Represents a portion of a transverse slice, highly magnified, from one of the most regular parts. This fossil exhibits a tendency to the concentric arrangement, but the limits of the layers are not distinguishable.

Fig. 2. A portion of the same: the appearance here presented is that generally exhibited by the mass. The dark reticulations evidently form no part of the regular texture, the direction of the series of cells being more or less changed by them.

Fig. 3. Representation of a portion of one of the more regular parts, intersected by a vein of earthy matter.

Fig. 4. From a more confused portion, but exhibiting the same general arrangement. The distortions produced by the introduction of foreign matter, or the partial decay and alteration of the texture, are here distinctly seen.

Fig. 5. This represents a portion of a transverse slice of a fossil vegetable, which was found in the neighbourhood of Newbiggin, on the coast of Northumberland, where similar stems are frequently exposed to view by the action of the waters. This fossil also presents an indistinct appearance of concentric layers. The terminal line of one of these layers is represented in the figure. The cells of the woody texture are disposed in very regular series. The dark lines are apparently medullary rays.

Fig. 6. The portion of the same fossil here represented, is that bordering upon an irregular vein of carbonaceous or earthy matter. The dark transverse lines in this and the preceding figure, are not truly the lines of separation of concentric layers, although some of them may occupy the space formed by the disruption of two of these layers.

Fig. 7. Representation of a portion of a fossil tree found at High Heworth, near Gateshead, in the county of Durham. It was met with in

the grindstone bed, which is the same stratum as that in which the great Wideopen tree (Figs. 1, 2, 3, 4.) occurred. The tree of which this figure represents a part, was described by Mr WINCH in a letter to the Geological Society, dated 7th October 1817. The trunk was 28 or 30 feet long, compressed and broken, lying in the regular dip of the sandstone, declining south. Where small interstices occurred, crystals of quartz were formed. It was otherwise fine-grained in texture, and in structure somewhat lamellar, apparently from the fibre of the wood. The general colour was pale brown, but parts of it were tinged black, probably by carbonaceous matter; the bark or outer part was converted into coal. The portion here represented is one of the most regular, and exhibits an arrangement similar to Figs. 1, and 2.

Fig. 8. Represents another portion of the same, exhibiting the ordinary appearance of the fossil, it being greatly distorted, and in some places intersected by earthy and carbonaceous veins. This so much resembles Fig. 2. and the texture of the fossil generally is so like that of the Wideopen tree, that the two very probably belong to the same species.

A specimen sent to me by Mr PHILLIPS of York, and which was found in the West Riding coal-field, possesses a texture so much resembling that of the fossil plants from the Newcastle district, that I have thought it unnecessary to present a figure of it.

FOSSIL VEGETABLES OF THE LIAS.

Fig. 1. Transverse section of a branch or trunk of a fossil tree found in the upper lias, about a mile south of Whitby, by Mr NICOL. The fragment of which this figure represents a face, is about 8 inches long, and has been split in the longitudinal direction. It has a very distinct concentric arrangement, and presents the marks of two branches or twigs. The exterior is irregularly and longitudinally striated, and was covered by a layer of coaly matter. The interior is intersected by veins of clayey matter, calcareous spar, and iron-pyrites. Some of the concentric layers are partially separated

and dislocated by the interjection of similar matter. The colour is dull brown, but a slice viewed by transmitted light is bright umber. This figure is of the natural size. It represents the central pith, the numerous concentric layers, the interjected foreign matter irregularly tortuous, or extending between the layers, and the white divergent veins of calcareous spar. Without further evidence, this fossil may decidedly be pronounced a coniferous tree; and the details presented by the following figures, shew the accuracy of the determination.

Fig. 2. A portion of a transverse slice, magnified about fifty-five times, shewing the ordinary appearance of the interior. Two of the limits of the concentric layers are seen, being filled by earthy and carbonaceous matter, which has in like manner been interposed in the direction of the medullary rays. The structure is similar to that exhibited by Figs. 1, 2, 3, 4, 5. of Plate I.

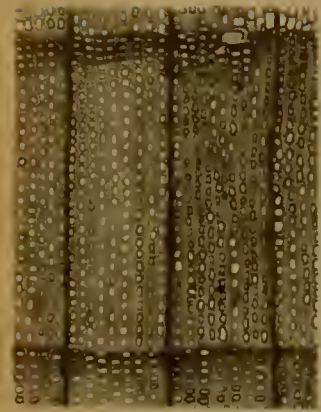
Fig. 3. A portion of a transverse slice of the same fossil, magnified about forty-five times. On comparing this and Fig. 2. with the figures representing portions of *Coniferæ* in Plate I., it will be seen that the cellules of the fossil plant here represented are considerably larger than those of the congeneric recent plants. In fact, the present figure, which is magnified forty-five times, has its meshes of about the same size as those of Plate I., which are enlarged about fifty-five times. Two of the limits of the concentric layers are seen in their original state. It is presumed that no person, on comparing the fossil here figured with the recent plants of Plate I. can for a moment doubt their ordinal identity.

Fig. 4. A portion of the same, enlarged about forty-five times, exhibiting the texture in its most delicate form. The black part is interjected earthy matter.

Fig. 5. This represents the central part, or pith, enlarged in the same degree as the last figure, together with part of the first woody layer, containing medullary rays. In fine, the fossil represented in these figures is clearly demonstrated to be a *Conifera*; and while we wonder that so delicate and regular a texture should have survived the lapse of ages, and the ruin of worlds, we cannot but feel gratified in being enabled to trace so in-



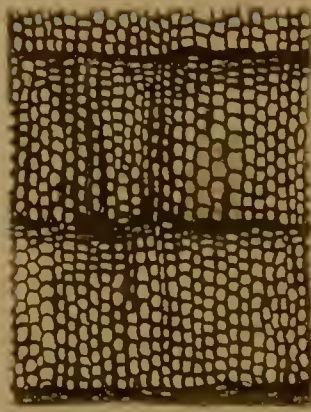
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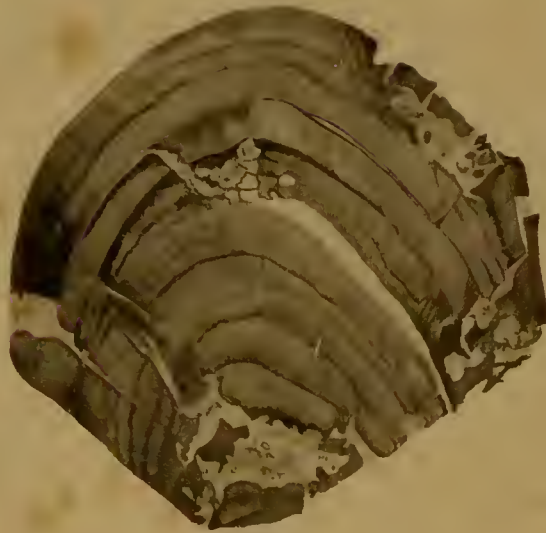
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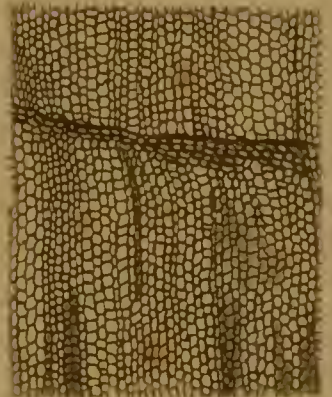
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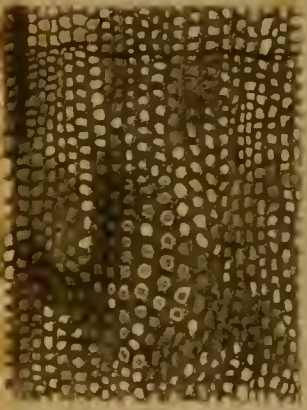
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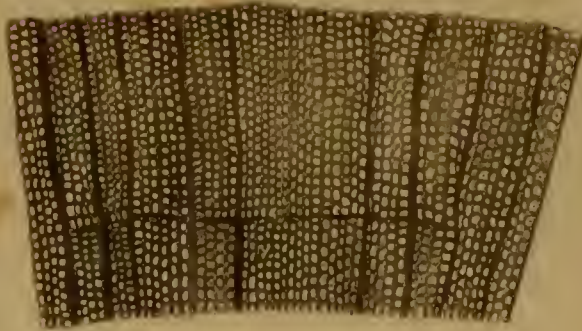
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timate a resemblance between plants belonging to epochs so remote from each other.

PLATE V.

FOSSIL VEGETABLES OF THE LIAS,—*continued.*

THE figures represent portions of thin transverse slices, viewed by transmitted light, and uniformly enlarged in the proportion of 55 to 1, excepting Fig. 6. which is of the natural size.

Fig. 1. Portion of a transverse section of fossil wood from the upper lias, near Whitby, to the south. This wood is in concentric layers, which, viewed by transmitted light, are amber-brown. The layers are separated by calcareous spar, so as to present a broken and confused appearance. The portion represented is one of the most regular, being from near the margin, where the layers are occasionally contiguous.

Fig. 2. This figure represents part of five layers near the centre of the same fossil. The irregular interruptions of the structure are filled with calcareous spar, and are not lacunæ, of which there are no traces in the regular portions. One of the most remarkable circumstances in the organization of this fossil, is the great difference in the breadth of the woody layers. Another is the difference in the texture, Fig. 1. presenting distinct medullary rays, while Fig. 2. wants them, being from a portion in which they are not observed. Fig. 1. also appears very different from Fig. 2. in the size and form of the cellules, but this difference arises solely from the circumstance that the former is from a thicker portion of the slice, similar differences in thickness producing corresponding differences in appearance, in the slices of recent plants.

Fig. 3. Portion of a slice of recent wood from the lias, near Whitby. In this wood, the concentric layers are very distinct, although, in some places,

they are variously distorted. This figure represents one of the most regular portions.

Fig. 4. Represents a distorted portion of the same. There are hardly any traces of medullary rays in this fossil, which is in general remarkable for the regularity and little breadth of its concentric layers.

Fig. 5. Portion of a section of fossil wood from the lias, near Whitby. In this wood, the concentric layers are very large and regular. It is especially remarkable for the regularity of the medullary rays, which present few intersections, but appear like continuous tubes.

Fig. 6. Transverse slice of a small portion of the most regular part of a very large mass found by Mr NICOL, in 1815, *in situ*, in the upper lias, about four miles north from Whitby, near Sandsend. It is very much disturbed by the intervention of calcareous spar, as is represented in the figure. The structure is concentric. The figure is of the natural size.

Fig. 7. Portion of the same magnified, shewing part of two concentric layers and their junction. In the unaltered parts, the structure is very regular, but exhibits few traces of medullary rays, and these not continuous. The meshes are about the size of those of our recent pines.

Fig. 8. Another portion of the same, magnified in the same degree, exhibiting the confused appearance resulting from the intervention of calcareous spar.

Fig. 9. Portion of a transverse slice of a fossil tree from the Whitby lias, shewing part of two layers. In this tree, the medullary rays are very distinct, as well as the concentric layers.

Fig. 10. Portion of a transverse slice of another tree from the Whitby lias, exhibiting the same general arrangement, but with much larger cellules.

Fig. 11. Portion of a transverse slice of a fossil tree from the grey limestone, near Whitby. The structure of this fossil is extremely distorted and altered by the intervention of calcareous spar, the cellular texture being thrust together in black masses. The portion represented is the most regular, many of the other parts being perfectly opaque.

Fig. 12. Portion of a transverse slice of another fossil tree from the Whitby lias. This, also, is very much distorted and broken up; but as little

can be learned from the exhibition of black and homogeneous masses, a portion exhibiting the regular texture of the plant has been selected.

Figs. 13, and 14. These represent portions of transverse slices of a fossil tree found in the Island of Egg, one of the Inner Hebrides. This fossil is the more interesting, that it appears to prove that certain beds of the oolitic series are always accompanied by plants of the higher classes. The beds in which it occurs, are so similar to those of Troternish, in the Island of Skye, that it is difficult, on minute comparison, to distinguish them. According to Messrs SEDGEWICK and MURCHISON, the Troternish beds are the upper strata of the great oolitic series, and resemble the Cornbrash and Forest Marble. The stem from which the slice, here partially represented, has been taken, was found at the base of the magnificent mural escarpment of the Scur of Egg, where the order of succession is much obscured by superficial accumulations of incoherent matter. The fossils of the lias generally are of a light brown colour, but this is remarkably dark. The concentric layers are very distinct, and the longitudinal fibrous structure similar to that of a recent tree. In the slice, lacunæ are seen sparsely and irregularly distributed. In the discrimination of individual fossil trees, much assistance is derived from the colouring, which, however, I have been obliged to omit in the figures. The Egg fossil is easily distinguished from all others which I have seen, by its deep black colour, and moreover possesses a peculiarly beautiful arrangement, better seen with the naked eye than with the microscope, and resulting from the distinctness of the medullary rays. The concentric layers are also very distinct.

In conclusion, there seems to me no reason to doubt the propriety of referring the whole of the fossils figured in this Plate to the Coniferæ. Fig. 7. bears a strong resemblance to Fig. 4. of Plate I., as do Figs. 13, and 14. But my object in the present publication is not to speak of generic identities, but to attempt the demonstration of ordinal relations.

PLATE VI.

THIS Plate contains representations of portions of thin slices of fossil vegetables of various kinds, viewed by transmitted light, and, with the exception of Fig. 9, greatly enlarged.

Fig. 1. Fossil wood found on the beach near Whitby, by Mr NICOL, in 1814. It exhibits distinct concentric layers, but is much broken up and distorted by calcareous spar. The figure represents the alteration thus produced in the regular structure, which is evidently that of the Coniferæ. It is enlarged about fifty-five times.

Fig. 2. Represents a portion of a longitudinal slice of part of one of the fossil vegetables from the Tweed, figured in Plates II. and III. The appearance is that of the liber of many recent trees, and is similar to that represented by Fig. 19. Plate xiv. of MIRBEL's *Elémens de Physiologie Végétale*. This figure is enlarged about fifty-five times.

Fig. 3. Represents a portion of a transverse slice of the Wideopen tree, figured in Plate IV. The portion here represented is one of the most regular, and has been enlarged about 100 times.

Fig. 4. Represents a portion of a transverse slice of a large fossil tree from New Holland, in the Museum of the University of Edinburgh. The structure is obviously similar to that of the trees represented in Plate IV. and therefore indicates a Conifera. This fossil, moreover, possesses very distinct concentric layers. I am indebted to the kindness of Professor JAMESON for the fragment from which the figure has been taken.

Fig. 5. Portion of a transverse slice of the Newbiggin tree, represented by Figs. 5. and 6. of Plate IV., and here enlarged about 100 times.

Fig. 6. Represents a portion of a transverse slice of silicified fossil wood, the locality of which is unknown. It is enlarged about fifty-five times, and resembles the Coniferæ in structure.

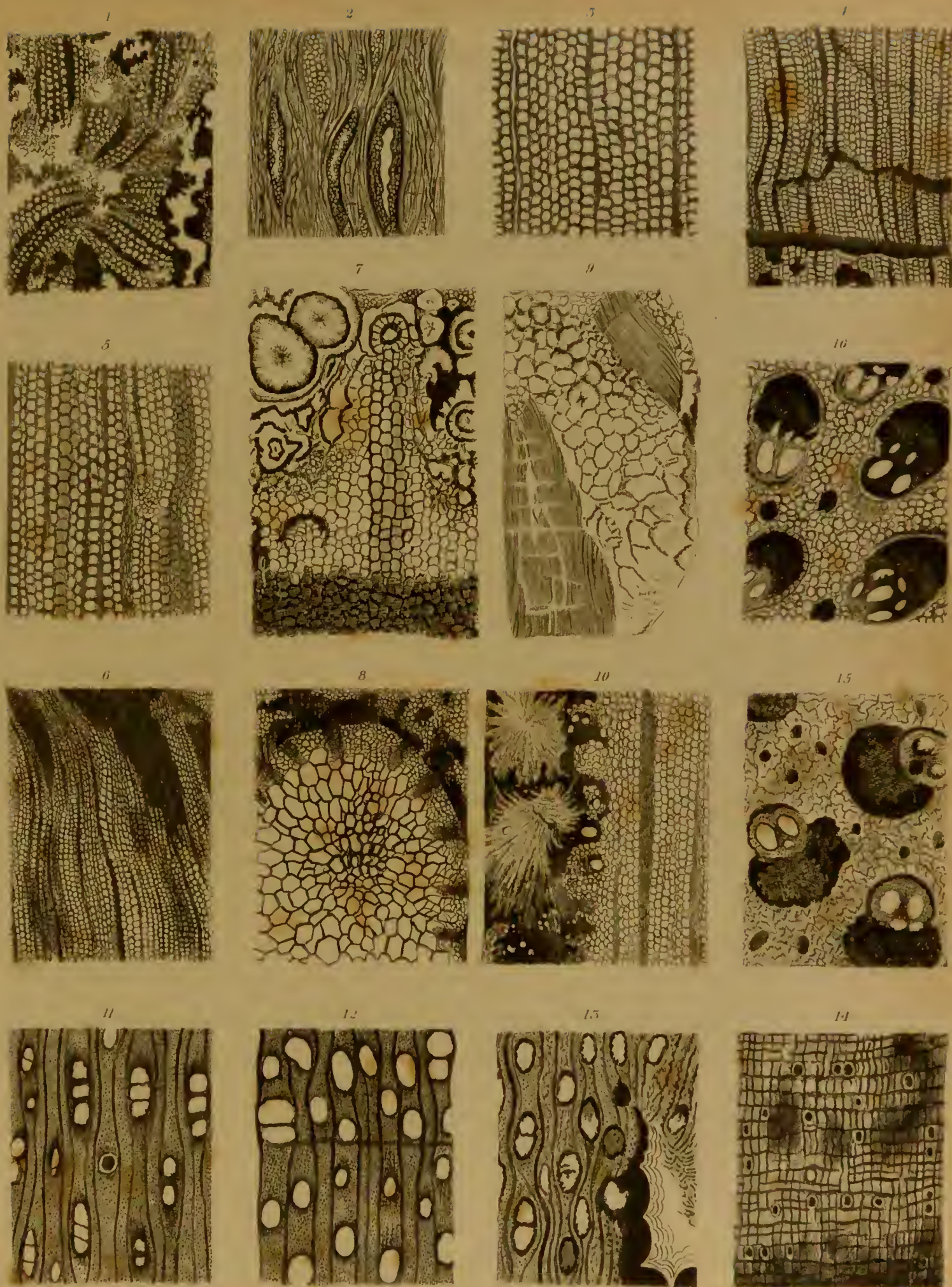




Fig. 7. Portion of a transverse slice of a fossil plant found at Allanbank Mill, near the junction of the Whitadder and Blackadder. This plant is externally roundish, and tapering. Its transverse section displays an irregular texture, intersected and distorted by calcareous spar. In some places are indistinct appearances of medullary rays, but there are no concentric layers. The cells toward the margin are very regular, more or less hexagonal, in series converging toward the centre, but broken up by the crystallizations, which assume various beautiful forms, as represented in the upper part of the figure.

Fig. 8. Attached to the roundish part, is an irregular darker coloured substance, apparently confused, but exhibiting a regular structure in various places, and having interspersed in it numerous oval forms, of part of one of which this figure is a representation. These oval forms very much resemble the pithy part of some dicotyledonous plants, as well as the stipe of various ferns. I have not, however, satisfied myself as to their real nature, and therefore cannot venture upon any opinion respecting them.

Fig. 9. Represents a portion of the Lennel Braes fossil, figured in Plates II. and III. The fragment of organic structure at the upper corner is silicified, and very regular. It presents the appearance of a line of junction between two concentric layers. This figure is of the natural size.

Fig. 10. The margin of the fragment indicated above, enlarged about fifty-five times. This figure displays the beautiful lace-like structure, broken up at the edge by calcareous spar, of which two divergent crystallizations are seen. This specimen shews very distinctly that the large cellular portions of the fossil in question are merely crystallizations, and not regular texture.

Fig. 11. Fossil silicified dicotyledonous wood, from Antigua, enlarged about fifty-five times. The structure greatly resembles that of the mahogany, represented in Plate I. Fig. 7.

Fig. 12. Fossil silicified dicotyledonous wood, from Antigua, enlarged about fifty-five times.

Fig. 13. Fossil silicified dicotyledonous wood, from Antigua, enlarged

about fifty-five times. The calcedonic mode of crystallization is observed at the lower part of the figure.

Fig. 14. Fossil silicified wood, from Antigua, probably dicotyledonous, and resembling Fig. 10. of Plate I.

On comparing Figs. 11, 12, 13, and 14. of this Plate, with Figs. 7, 8, 9, and 10, of Plate I., it will be seen that the general resemblance is perfect; and that there can hardly remain a possibility of confounding the structure of the dicotyledonous trees with that of the Gymnospermous phanerogamic.

Figs. 15, and 16. Represent portions of silicified monocotyledonous wood from Antigua, and may be compared with Figs. 11. and 12. of Plate I., which exhibit the same structure. They are enlarged about fifty-five times.

Since the drawings have been finally arranged, I have received from my much esteemed friend, Mr SINCLAIR of Ulbster, a specimen of fossil wood, which proves to be one of the Coniferæ. The following is a brief account of it. This tree was found in 1829, in a quarry in Portland Island, about 200 feet above the sea, and about 10 feet below the surface of the ground. Immediately over it was a bed of roofing-slate; and above the slate a bed of stone about two feet in thickness. The trunk of the tree is 24 feet in length, and divided into two remnants of branches, about four feet long each. The stem measures four feet in circumference, just above the root, and the whole of it is rather oval than round, apparently from the pressure of the materials above it, as it was found in a horizontal position.

SECTION IV.

CONCLUDING REMARKS ON THE VEGETABLES REPRESENTED IN THE PLATES,
AND ON FOSSIL VEGETABLES IN GENERAL, TOGETHER WITH AN AC-
COUNT OF THE MANNER IN WHICH SLICES ARE OBTAINED FOR MICRO-
SCOPIC EXAMINATION.

THE first general remark which I have to offer respecting the fossil vegetables figured in the Plates, is, that their concentric layers present the same irregularity as those of our recent plants. It will be seen from Figs. 1, 2, and 6. of Plate V., and from Fig. 1. of the lower part of Plate IV. in particular, that some of these layers are much broader than others in the same species. An inference to be made from this circumstance is, that the climate which existed at the epochs when these vegetables grew, resembled ours in the irregularity of its successive summers. If, at the present day, a warm and moist summer produces a broader annual layer of wood, than a cold or dry one, and if fossil plants exhibit such appearances as we refer in recent plants to a diversity of summers, then it is reasonable to suppose that a similar diversity formerly prevailed.

The Coniferæ of the coal-formation and mountain limestone group, have few and slight appearances of the lines by which the annual layers are separated. The trees of our present tropical regions have also few and slight appearances of these lines. Therefore, at the epochs of these formations, the changes of season were probably as little marked as they are in our tropical regions.

Again, the condensation observed towards the outer margin of each woody layer of the trees of our cold and temperate climates, and which is attributed to the increasing cold of the latter part of the autumnal season, is

decidedly observable in the Coniferæ of the lias; as in Figs. 3, and 4, of the lower part of Plate IV., and in Figs. 1, 2, and 3, of Plate V. Therefore, at the epoch when the trees of the lias grew, there was a cold season as now.

Between the monocotyledonous fossil and recent species which I have figured, no comparison can be instituted, as they are not of the same species; but it may be remarked generally, that, so far as I have examined these plants, the recent species have smaller cells and vessels than the fossil.

The same remark is to be made of the dicotyledonous woods.

Of the recent Coniferæ, figured in Plate I., Figs. 1, 2, 3, and 4, are of climates similar to that in which the fossil Coniferæ figured in Plates II, III, IV, V, and VI. occur. Still, even here, no accurate comparison can be instituted, as we cannot decide upon the genera, much less upon the species, of the fossil plants. But it may be generally remarked, that the cells or tubes of the latter are, in almost every case, much larger than those of the former. Thus, Figs. 1, 2, 3, 4, 5, 6, 7, and 8, of Plate IV., which are enlarged in the same degree as Figs. 1, 2, 3, and 4, of Plate I., have much larger meshes than the latter; while Fig. 3. of the lower part of Plate IV. has its meshes as large as those of the recent Coniferæ in Plate I., although enlarged in a much less degree.

Our observations on this subject, however, are not sufficiently numerous or correct, to authorize any inferences as to the comparative vigour of the vegetation of the different epochs, although they are sufficient, along with other circumstances, to render it not improbable that the temperature was higher at the periods when the fossil vegetables grew than it is now.

The general colour of the fossil vegetables, retaining their organic texture, which occur in our mountain limestone groups, coal-fields, and lias deposits, is brown, of various tints, more commonly wood-brown, frequently umber, and sometimes greyish or blackish-brown. These fossils are all more or less calcareous, and the veins by which they are frequently intersected, are generally of calcareous spar. Those fossils, on the contrary, which, occurring in the same formations, are destitute of organic texture, have their interior

filled with substances analogous to those of which the strata containing them are composed.

Silicified fossils occur more abundantly in the superior formations, and are generally of a lighter colour. The calcedonic monocotyledonous and dicotyledonous fossils of the West Indies vary in colour from yellowish-white to reddish-brown, or even bright red, but seldom or never assume tints so dark as those of our inferior deposits.

With respect to the fossil vegetables of which I have presented figures, I may here again remark, that, notwithstanding the want of well-defined concentric layers in those of the coal-formation and mountain limestone group, no doubt remains with me as to their being Coniferæ. Should it be shewn, by future investigations, that recent plants of other classes present a similarity of structure, the case will become different; but until then, it will remain established that these fossil plants come nearer to the structure of the Coniferæ than to that of any other tribe. As to the fossils of the lias, I presume no doubt can henceforth remain in the mind of any one who may compare them with recent Coniferæ, or be satisfied with the accuracy of my representations.

It may be well, in this place, briefly to recapitulate my observations, and mark out those fossil plants which I am inclined to consider as distinct species:

1. The fossil vegetable from Lennel Braes, on the Tweed, represented in Plates II. and III., and by Figs. 7, and 8, of Plate VI., belongs to the mountain limestone group.
2. That from Craighleith Quarry, near Edinburgh, represented by the lower figures of Plate III., belongs either to the mountain limestone group or to the coal-formation.
3. The Wideopen tree, represented by Figs. 1, 2, 3, and 4, of Plate IV., and by Fig. 3. of Plate VI., is of the coal-formation. The High Heworth tree, represented by Figs. 7, and 8, of Plate IV., which is from the same stratum as the Wideopen tree, is probably of the same species.

4. The Newbiggin tree, represented by Figs. 5, and 6, of Plate IV., and by Fig. 5, of Plate VI. belongs to the coal-formation.
5. The fossil tree from near Whitby, figured in the lower part of Plate IV. is of the lias ; as are all the following.
6. That from near Whitby, represented by Figs. 1, and 2, of Plate V.
7. That represented by Figs. 3, and 4, of Plate V.
8. That represented by Fig. 5, of Plate V., and distinguished from the others by the regularity of its medullary rays.
9. That represented by Figs. 6, 7, and 8, of Plate V.
10. The fossil vegetables of the Grey Limestone, represented by Fig. 11. of Plate V.
11. That from near Whitby, represented by Fig. 12. of the same Plate.
12. The Egg fossil, represented by Figs. 13, and 14, of Plate V.

The fossils from near Whitby, represented by Figs. 9, and 10, of Plate V., are probably of the same species as some of those mentioned above ; while, with respect to that also from near Whitby, represented by Fig. 1, of Plate VI., it cannot be decided whether it is a different species or not.

Here, then, we have of fossil plants, indisputably Coniferæ, at least eight species belonging to the Lias, and of plants to all appearance of the same family, belonging to the Coal-formation or Mountain Limestone Group, four species. The determination of these plants is of some importance to geology, it having been denied that any trees of the family to which they belong occur in these formations. Future investigations will no doubt disclose many other species.

The determination of these fossils, then, constitutes the principal result of my investigations. I shall also enjoy the pleasure of having solicited the attention of geologists to the internal structure of fossil plants generally ; and, had the present work no other merit, I should feel proud of having, in however small a degree, facilitated the progress of my fellow-travellers up the steep ascent of science.

Should the subject receive the attention of some of the many eminent

botanists and geologists of which our country can boast, one great object which I have had in view will be accomplished. In the mean time, however, I shall not fail to prosecute the investigation myself.

The subjects that may receive elucidation from a prosecution of this examination, are various and important. Thus, if it were determined what fossil genera have their stems compressed, and converted entirely into carbonaceous matter, or what species have them hollowed, and filled with sand or clay, the cortical part alone remaining, or preserve their internal texture more or less entire; or, in the latter case, are filled with siliceous, or with calcareous, infiltrations; we should be better enabled to understand the circumstances in which these plants existed, or were buried in the strata, as well as the mode in which the changes operated upon them have been effected. Some light may also be thrown upon the organization of recent vegetables, by the appearances presented by the fossil species. Thus, the double nature of the walls of the cellular tissue, denied by some, appears to me established by appearances exhibited by fossil plants.

It seems somewhat strange, that, notwithstanding the number of works in which representations are given of stems, none should have come into my hands that present a satisfactory comparative view of the differences of the three classes represented in Plate I. This being the case, I may hope that the present work will, in so far, be useful to the student of vegetable anatomy.

It now only remains for me to assist the geologist who may be desirous of viewing these fossil plants for himself, in preparing the objects for the microscope. I have the pleasure of laying before my readers a full account of the process, for which I am indebted to Mr NICOL.

Let a thin slice be cut off from the fossil wood, in a direction perpendicular to the length of its fibres. The slice thus obtained must be ground perfectly flat, and then polished. The polished surface is to be cemented to a piece of plate or mirror glass, a little larger than itself, and this may be done by means of Canada balsam. A thin layer of that substance must be applied to the polished surface of the slice, and also to one side of the glass.

The slice and the glass are now to be laid on any thin plate of metal, as a common fire-shovel, and gradually heated over a slow fire, with a view to concentrate the balsam. In performing this operation, it will be requisite to prevent the heat from becoming so great as to throw the balsam into a state of ebullition; for, if air-bubbles be once formed in it, it will be difficult to remove them, and if they are not removed, they will prevent the complete adhesion of the two surfaces when applied to each other. The heat of the shovel should never become so great that the fingers may not be held in contact with it, without inconvenience, for a few seconds. With every precaution, some few air-bubbles will sometimes make their appearance, but these may be removed by a small piece of wood tapering to a point. When the balsam is thought to be sufficiently concentrated, and all air-bubbles completely removed, the slice and the glass may be taken from the shovel, and applied to each other. A slight degree of pressure will be necessary to expel the superabundant balsam, and this will be facilitated by gently sliding the one on the other. By this kind of motion, any air that might have got entangled in the balsam, when the surfaces were brought into contact, will also be removed.

When the whole is cooled down to the temperature of the air, and the balsam becomes solid, that part of the balsam adhering to the surface of the glass surrounding the slice should be removed by the point of a pen-knife; and it may be right to remark, that, in this operation, it will at once be seen whether the balsam has undergone the requisite concentration. If, for instance, it has entirely lost its sectility, and starts off in flakes before the knife, it will be found that the slice and the glass will cohere so firmly, that, in the subsequent grinding, there will be no risk of their separating from each other. If the balsam has not been sufficiently concentrated, it will slide before the knife, and, in that case, the two bodies will not adhere with sufficient firmness. A very few trials, however, will enable any one to conduct the process with success; and it may be right to add, that, if the layer of balsam applied to the two surfaces be not too thick, its due concentration may be accomplished in four or five minutes, provided the application of the heat be duly regulated.

The slice must now be ground down to that degree of thinness which will permit its structure to be seen by help of a microscope. To facilitate this part of the grinding, the lapidary will find it advantageous to fix the glass in a groove made in a small piece of wood, of which half inch thick deal will answer the purpose. The groove in the wood should be a little less deep than the thickness of the glass, and the wood itself need not project more than half an inch beyond each side of the glass.

A lapidary, by attending to the above directions, will find no difficulty in reducing any piece of petrified wood to that degree of thinness sufficient to render its structure visible; and any one, even without the aid of the mechanism employed by the lapidary, may accomplish that object by attending to the following directions.

The position of the fibres of the wood having been ascertained, let a thin piece be chipped off by a blow of a hammer, in a direction perpendicular to the length of the fibres. Let the chip thus obtained be cemented to any small bit of wood by common lapidaries' cement (a compound of 1 part bees' wax, 1 part pitch, 4 parts rosin, 16 parts of a mixture of brick-dust and whitening), to enable the operator to hold it firmly while the grinding is going on. That side of the chip which approaches nearest to a perpendicular to the length of the fibres, must be ground flat, by giving it a rapid circular motion with the hand, on a piece of sheet-lead lying horizontally on a table, and supplied with a little emery, size No. 1., moistened with water. When the emery ceases to act, the muddy matter remaining may be removed, and a fresh portion of emery applied; and this must be repeated until the surface of the chip has become perfectly flat. The sheet of lead must then be removed, and a piece of flat sheet copper substituted, and the surface of the chip ground as smooth as may be, by flower of emery, freed from its coarser parts. The surface may then be polished by friction with crocus or rot-stone, on a transverse section of any soft wood.

When the polishing is finished, the chip must be detached from the wood to which it was cemented, and the polished surface cemented by Canada balsam to a piece of plate-glass, in the manner above described, and then ground thin, and polished as before.

In conclusion, I have only further to say, that should any one feel interested in the subject, he may have his desire for information gratified, by the inspection of the specimens from which the figures in this work have been taken, as well as of the numerous other fossil vegetables in my Museum, which has always been open to the cultivator of science.

THE END.